Defense Technical Information Center Compilation Part Notice

ADP010322

TITLE: An analysis on Operability of Tactical Unmanned Aerial Vehicle Systems over Turkish Territory

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Advances in Vehicle Systems Concepts and Integration. [les Avancees en concepts systemes pour vehicules et en integration]

To order the complete compilation report, use: ADA381871

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, ect. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:

ADP010300 thru ADP010339

UNCLASSIFIED

An analysis on Operability of Tactical Unmanned Aerial Vehicle Systems over Turkish Territory

Özcan ERTEM
Design & Development Dept.
Tusaş Aerospace Industries
İstanbul Yolu 30.km Akıncı
06936, Ankara
Turkey

Gökhan MANDAŞ
Design & Development Dept.
Tusaş Aerospace Industries
İstanbul Yolu 30.km Akıncı
06936, Ankara
Turkey

The requirements for operational arena of Tactical Unmanned Aerial Vehicles (TUAV) are highly effected with the geographical and weather conditions. A TUAV requirement for a flat terrain with moderate weather over the year varies dramatically from a mountainous terrain with severe weather conditions. Availability of the infrastructure such as airfields, highways is another contributing factor towards the system requirements. Transportability brings another concern when TUAV system is to be deployed by existing aerial assets. This paper evaluates the conditions of Turkish territory and infrastructure; transportability/mobility and therefore tries to approach to the best set of requirements for a TUAV system, with a review of crew and ground vehicles that can operate in Turkish Armed Forces.

WHY TACTICAL UAV SYSTEM:

To bring real-time information to the front-line commander is the major driving force to utilize a TUAV system. The areas of interest in several cases may begin from 50 km. in range and sometimes extend up to 200 km. Even though a long range/Endurance UAV (EUAV) may well serve for strategic operations, to provide tactical picture to several front-line units can sometimes be ineffective if not impossible with those systems. To be able to re-deploy a UAV system according to the changing threats/conditions is critical and requires a local/mobile control station for a EUAV. A TUAV system, on the other hand can be deployed as a whole.

The two most challenging performance parameters for UAV systems are time-on-station (TOS) and time-on-transition (TOT). TOT can be defined as total time spent to fly to/from the mission area, whereas TOS, as the name implies, is the time over the target area. These parameters combined with coverage area forms the critical threshold between TUAV and EUAV's. Today's fast moving land/sea based threats requires a rapidly responding reconnaissance units. TOT for regiment or brigade level deployed UAV's should have a maximum value of one hour. This calls for either a fast-flying UAV that can fly to station from long-distance airfields or a rather slower UAV system to be airborned within 50 kms of range.

GEOGRAPHY OF TURKEY

Turkey, with 780,000 sqkm of land has a variety of geographical and meteorological areas. An analysis of a UAV system with various ranges of operation shows the comparison of 50km, 100km and 150km circles. Figure 1, Figure 2 and Figure 3, illustrate the distribution of these ranges of operation circles over Turkey with maximum possible coverage area.

The Table 1 shows the number of circles to cover Turkey, and percentage of these which has airfield within their coverage area. The situation will further be limited if major areas such as South-Eastern sector of Turkey is considered. (Zone SE)

Table 1 Airfield Coverage

	# of circles	airfield %	airfield % Zone SE
50 km	129	47	43
100 km	46	90	80
150 km	25	96	83

A UAV system to fly at 55 kts.(100 km/hr) with 10 hrs of endurance will have a flight profile like in Figure 4. Based on this timing, Figure 5 illustrates the number of sorties required to obtain a +24 hrs of coverage of a mission area.

As seen on these figures, TOT is a very critical factor on system effectiveness. Shortening this parameter certainly improves the operability of the system and decreases the number of sorties required.

Paper presented at the RTO SCI Symposium on "Warfare Automation: Procedures and Techniques for Unmanned Vehicles", held in Ankara, Turkey, 26-28 April 1999 and published in RTO MP-44.

Increasing the speed of the vehicle can help time savings on TOT, however to fly faster, engine power should be increased which results in higher fuel consumptions. Therefore the most effective solution to keep TOT at minimum for TUAV system appears to be stationing closer to the mission area. This will also have additional benefits like :

1. Quick reaction time to be on station with sudden threats.
2. Spend minimum time to recover in adverse conditions like severe weather changes (icing) or system malfunctioning.

Table 1 shows that increasing range of operation to 100 km. favors towards conventional UAV's (wheeled type, airfield requiring) with respect to catapult launched/chute recovered systems. Even in Zone SE, the situation appears acceptable.

However, the line-of-sight (LOS) data-link will bring some drawbacks while flying over this mountaneous territory. The aircraft either have to fly high to talk to Ground Control Station (GCS) which results in lower resolution of payload images or utilize ground/airborne data relay systems to talk to even ranges like 100 km. This being an additional complexing element to TUAV system would exceed the scope of being small and versatile.

For TUAV systems with 50kms of range since the airfields will not be available at ranges of interest, new solutions need to be created:

1. The aircrafts should be operable from semi-prepared runways. This can be a solution for some areas, though it can not be applied to all coverage areas especially for Zone SE.
2. Take-off/landings (TOL) should not require runways. This being a better solution with 100% coverage even at a mountaneous area, will bring additional requirements and options to TUAV system :

Vertical TOL UAV systems: To take-off from a designated area is not complicated for these vehicles. In addition to that where landing accuracy needs to be within 1 meter or so, VTOL UAV's appear to be the best solution. Therefore, especially for over the ship deck operations, VTOL UAV system is the best and only solution.

The major drawback of VTOL systems is the limited payload capacity compared to the similar weight/ powered fixed wing-conventional UAV systems. This is due to the nature of vertical flight where a bigger engine is required for a safe take-off/landing which has great implications on fuel-weight and range or endurance.

Catapult Launch/Chute Recovery systems: To perform an assisted take-off by means of a catapult, launcher or rocket, is again acomplicated solution to certain extent. This solution being less payload capable compared to wheeled aircrafts, is better than VTOL UAV's in terms of capacity or performance. If landing accuracy has a margin about 100 m.'s, this solution is the best of non-airfield requiring options.

Based on these evaluations especially for Zone SE tactical operations where a landing accuracy can be tolerated to 100m.'s, a catapult launched/chute recovered TUAV system can possibly provide the best effectivity.

TRANSPORTABILITY/MOBILITY

Fast-moving threats have great influence on the requirements of TUAV's. Unlike EUAV's, tactical commanders have the necessity to deploy TUAV system elements to varying distances very frequently.

For short range deployments, TUAV system has to be packed, moved and prepared back for flight in comparable times to its flight time. Like TOT parameter, TUAV system with all ground elements should be in move in less than an hour after the recovery. Even though there won't be any aircraft flying during the move, to save time some basic functions such as mission planning, backbone communication, flight de-briefing should be operable if needed. Similarly at the new launch area, total time to fly from parking should again be less than an hour.

The highways and operational areas especially on Zone SE, requires ruggedized moving vehicles with some off-road capability. Therefore unlike EUAV systems where system generally stays on an airfield, TUAV vehicles and trailers should be self-sufficient, self-sustaining rather small scale systems.

Instead of shelters temporarily loaded on trucks, ground shelters and other equipment should be an integral part of the moving vehicles. See Figure 6 and Figure 7.

In the case of +24 hrs. coverage requirement, which can be obtained with three aircrafts, Ground Support Vehicle (GSV) carrying capacity should not exceed four unmounted vehicles/payloads. Total number of ground vehicles should be two or max. three each with support trailers like Ground Data Terminal (GDT) or power generators.

For long distance deployments all vehicles and trailers should be sized to fit in cargo aircraft of TuAF. It is expected to limit number of sorties to minimum but even light transport aircraft CN-235 should be able to lift some basic elements. An analysis of cargo compartments of these aircrafts show that the system outer dimensions should fit in the envelope as shown in Table 2.

Table 2 Internal Dimensions of Cargo Aircrafts

	C-130	C-160	CN-235
X	1250 cm	1350 cm	965 cm
Y	302 cm	315 cm	236 cm
Z	271 cm	200 cm	190 cm

where X,Y and Z dimensions are length, width and height of cargo compartments respectively.

CREW REQUIREMENTS

In case where a TUAV system consisting of three/four aircraft, GCS, GDT and support equipment can be packed into two integrated ground vehicles and their trailers, the number of personnel to move and operate this sytem becomes a very important parameter. This, being a very important factor to determine number of consoles and task distribution, requires a compact, multi-roled team to accomplish the mission.

It is expected to perform missions including two simultaneously flying aircraft by only six well-trained personnel.

Unit Commander (UC) : Being essentially a reconnaissance team, unit commander is responsible from the complete flight operation of TUAV system. Pre-flight mission planning, backbone communication, payload operations and image/data evaluation tasks are expected to be performed by UC.

First Pilot (P1) : Being senior pilot of the unit and second commander, this serviceman is responsible from preparing and flying #1 aircraft and assisting flight planning.

Second Pilot (P2) : Being second pilot, this serviceman is responsible from preparing and flying #2 aircraft, recovering and performing O-level maintenance on aircrafts. He/she can also operate payload system.

First Payload Operator (PL1) : All payload operations on GCS especially for #1 aircraft and O-level maintenance of payloads, fall within the responsibilities of this serviceman.

First Technician (T1) : This serviceman is responsible from preparing ground systems to flight after deployment, O-level maintenance of ground vehicles, GDT and generator. During deployment, driving task of one ground vehicle belongs to this serviceman.

Second Technician (T2) . Similar to T1, this serviceman performs tasks on ground systems and drives second ground vehicle.

VEHICLE REQUIREMENTS

In order to fulfil the requirements of missions, transportation, mobility in Turkish territory, TUAV system vehicles should be arranged with the following configuration. This will also let system to comply with minimum crew requirements.

Ground Vehicle No.1: (GCS) This vehicle to carry integrated and sheltered ground control station is the heart of the system. Inside the shelter, there exist two consoles with an extension for a third laptop workstation and accommodation for three crew. One workstation with high-resolution graphical display is allocated for payload operations and can display real-time video or imagery. Besides payload tasks during the mission, it can also be utilized for post flight analysis by means of playing recorded payload imagery to perform intelligence tasks regarding targets involved. Second task is especially critical for payload data evaluation and also enables the operator to plan consequent flights. This utility should be operable even when TUAV system is in movement towards new deployment area.

The other workstation is used for flight planning and execution, and operated by mission planner/pilot. With the graphical representation of digital maps and airborne status, the pilot can re-plan flight path or manually fly the vehicle. For emergency reasons the tasks of these two workstations should have switching capability.

All system data including payload imagery should be recorded; and a hardcopy format output such as videotape or printed material should be available.

Second important task of GCS vehicle is communications. The radiating segment of the system, GDT, is planned to be mounted on a trailer and towed by this vehicle. Even on the move, some communication capabilities should be available to TUAV staff to basically include backbone communication to the headquarters and front-line commanders. Once the system is deployed and becomes operational at the mission area, the GCS-GDT couple works to communicate with air vehicle(s). At this place, GDT should be detached from the vehicle and displaced to a safe distance to GCS to avoid airborne attack damages.

A closed system communication (intercom) should be established between GCS and ground personnel. This utility, together with an external aircraft controller system will enable ground personnel to prepare or test other vehicles on ground without any RF radiation. The same controller system with LOS link capability, provides a backup aircraft control to recover already airborned vehicle if there exist a GCS system failure.

Ground Vehicle No.2 (GSV) This vehicle to carry three/four dismounted aircrafts is the support segment of TUAV system. While deploying, this vehicle can house both aircrafts and payloads at sheltered, safe closets. The launching equipment should be mounted to this vehicle while taking transportability requirements mentioned above into consideration. A tent to perform outdoor operations such as complete aircraft testing should be available with this vehicle. An intercom capability to talk GCS is another requirement. Figure 8 illustrates a complete TUAV system with all ground elements.

The main electrical supply of the whole system is a generator. Due to spatial requirements, this should be mounted on a trailer to be towed by GSV. Another important requirement associated with the generator and all running engines is to be able run with same type of fuel. This being a very important factor in terms of practicality of the system, will certainly avoid different fuel storing requirements. MOGAS or heavy-fuel for diesel engines will let system be operable with readily available fuel sources. This selection should involve everything including aircraft engines, ground vehicle engines and generators. The sufficient fuel for a complete mission should also be stored either in generator tank or GSV tank.

CONCLUSION

TUAV system requirements for Turkey have some peculiarities related with the operational conditions. Based on existing infrastructure of airfields, highways; a TUAV system with 50km. of radius of operation has to be of launched/chute recovery type. The whole system, to be a quick response unit for changing threats; should fit into existing cargo aircrafts and should have two well integrated ground vehicles with towed trailers. Common fuel concept should be applied to all system elements, and most important of all, to increase effectiveness, the complete system should be operable minimum number of personnel not to exceed six for a two ground vehicle version.

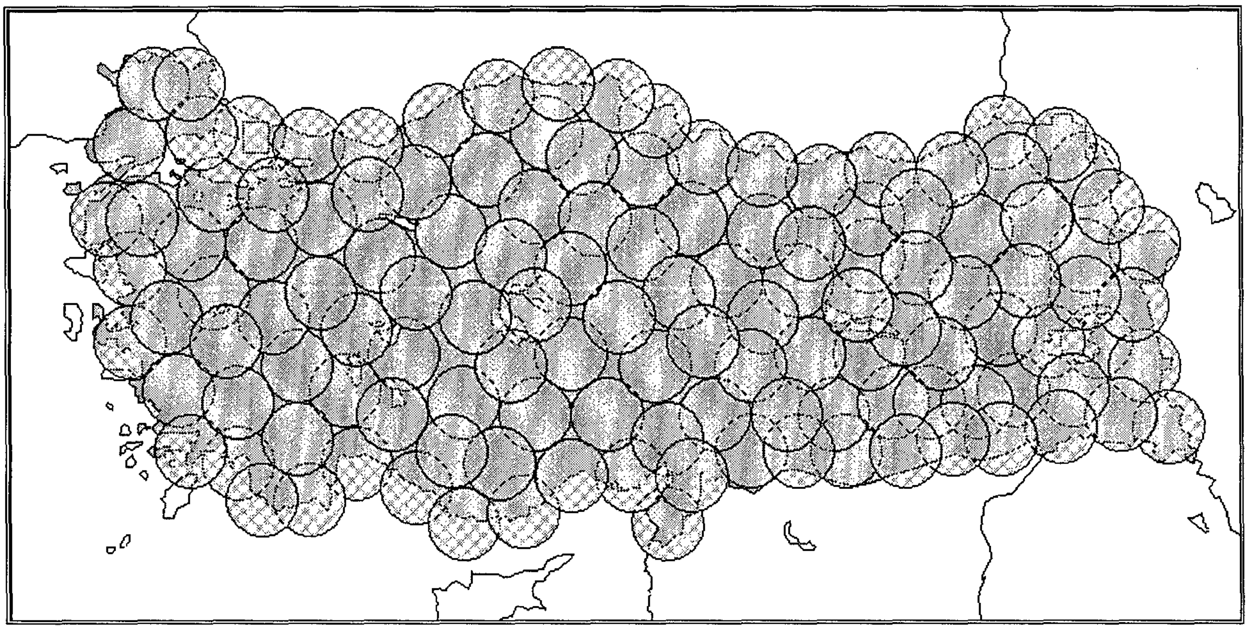

Figure 1 50km Range Coverage

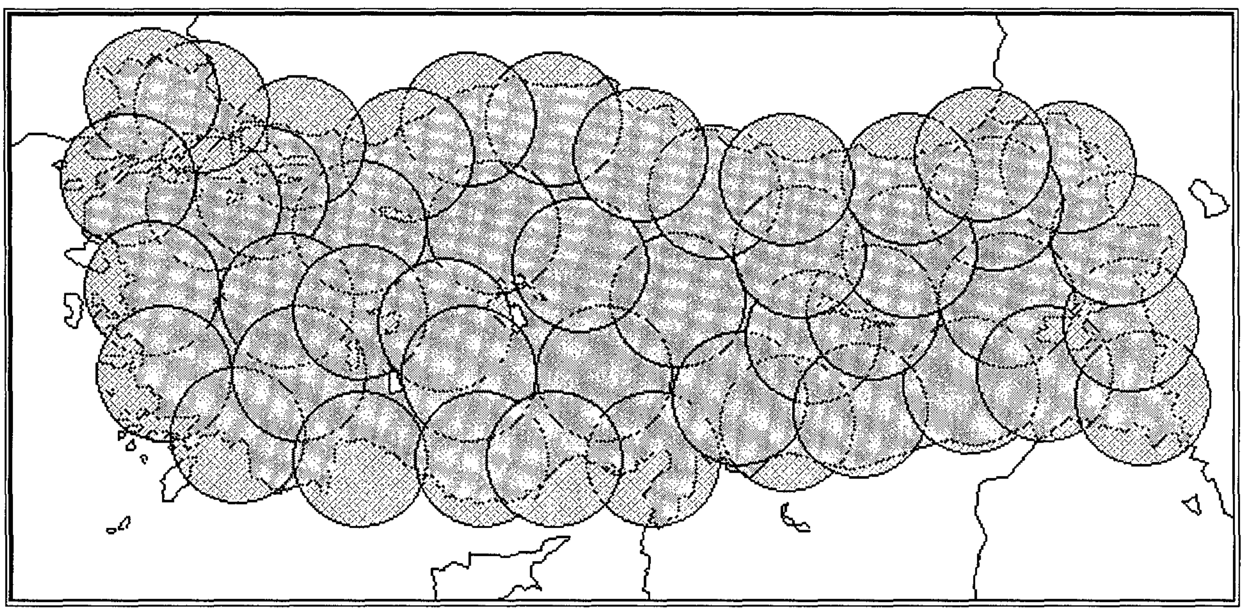

Figure 2 100km Range Coverage

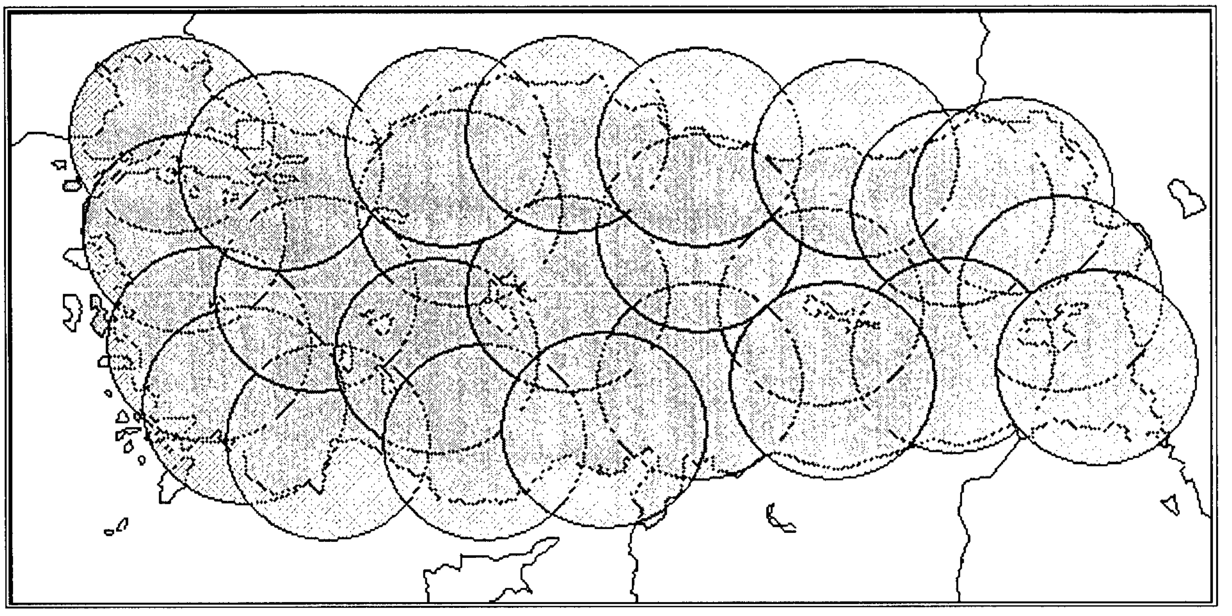

Figure 3 150km Range Coverage

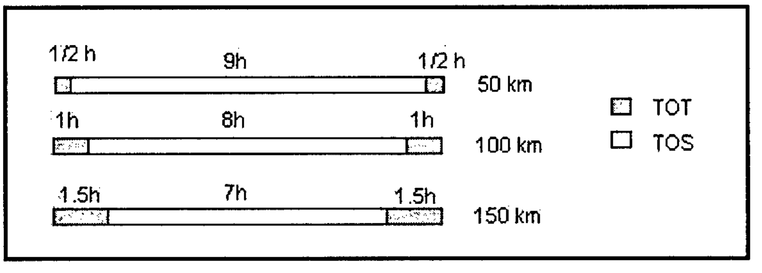

Figure 4 Flight Phases vs Ranges

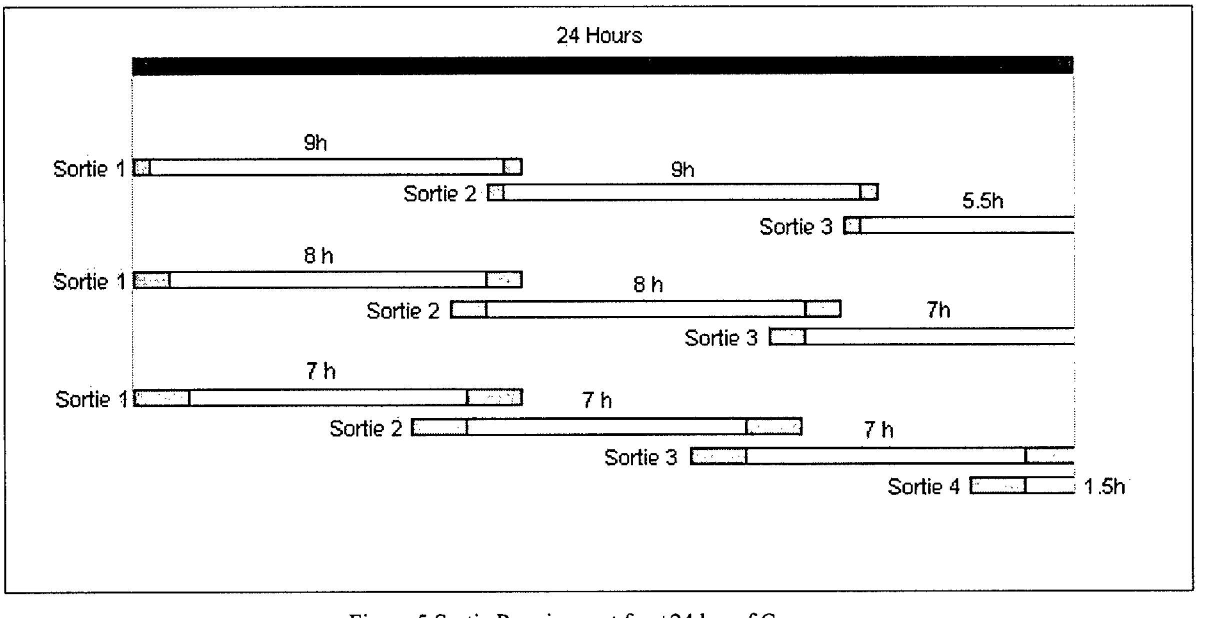

Figure 5 Sortie Requirement for +24 hrs of Coverage

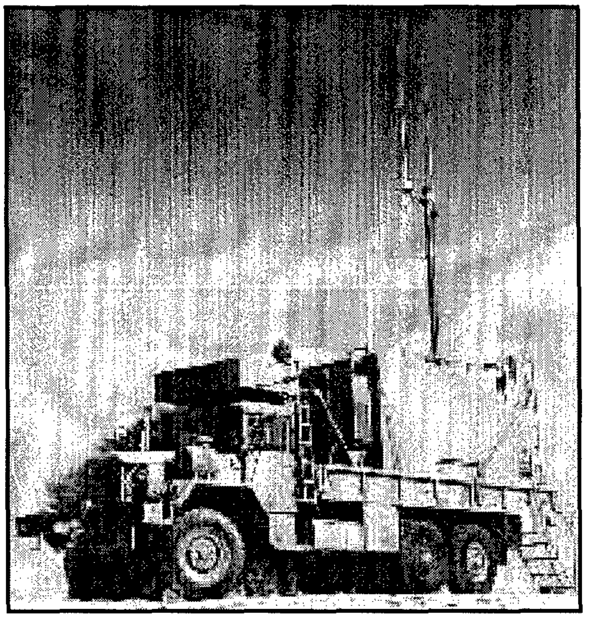

Figure 6 GCS Shelter loaded on Truck

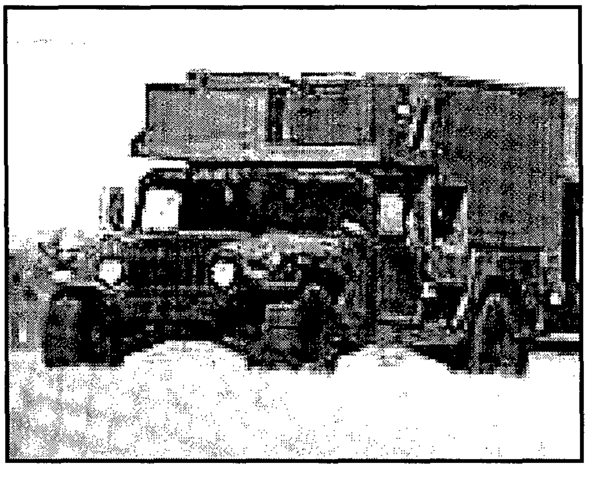

Figure 7 GCS Shelter integrated on Truck

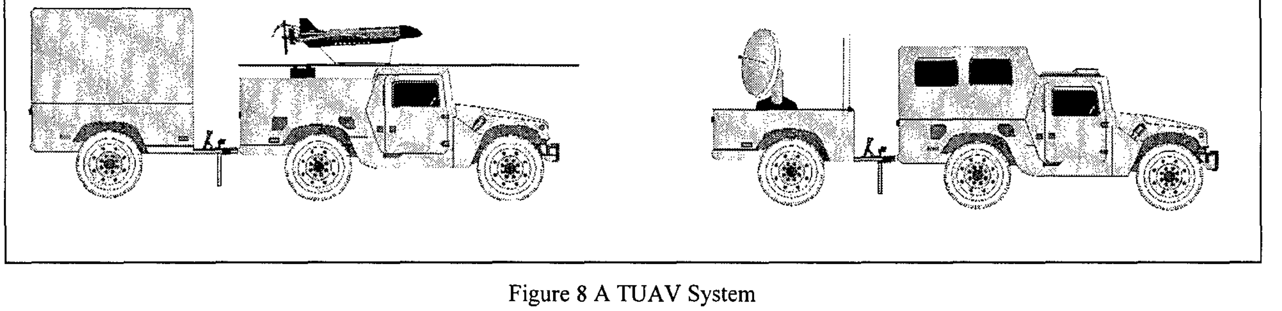

Figure 8 A TUAV System